



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04Q 7/38, 7/22		A1	(11) International Publication Number: WO 00/16579 (43) International Publication Date: 23 March 2000 (23.03.00)
<p>(21) International Application Number: PCT/FI99/00750</p> <p>(22) International Filing Date: 14 September 1999 (14.09.99)</p> <p>(30) Priority Data: 981976 14 September 1998 (14.09.98) FI</p> <p>(71) Applicant (for all designated States except US): NOKIA NETWORKS OY [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).</p> <p>(72) Inventor; and</p> <p>(75) Inventor/Applicant (for US only): MUHONEN, Ahti [FI/FI]; Itälahdenkatu 5 B 37, FIN-00210 Helsinki (FI).</p> <p>(74) Agent: KOLSTER OY AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).</p>		<p>(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), DM, EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>	
<p>(54) Title: CHARGING OF SUBSCRIBERS WITH LOCALISED SERVICE AREAS IN A MOBILE TELECOMMUNICATIONS NETWORK</p> <p>(57) Abstract</p> <p>A mobility support element (MSC/VLR; SGSN, GGSN) for a cellular radio network supporting circuit-switched and packet-switched connections to/from a mobile station (MS). For each mobile station (MS), there is a set (LSA1, LSA2) of special cells (C1 – C3, C9, C10) providing special service. A radio control element (BSC1, BSC2) determines whether the mobile station (MS) is in a special cell. Charging elements (CG, BC) receive charging information comprising detail items which indicate events which affect charging. The mobility support element (MSC/VLR; SGSN, GGSN) receives, when it begins to serve the mobile station, a list (LSA1, LSA2) of the special cells for the mobile station, and sends the list to the serving radio control element (BSC1, BSC2). The mobility support element also supports or performs classification of the detail items into two classes depending on whether or not the corresponding event occurred while the mobile station was in a special cell.</p>			

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Charging of subscribers with localised service areas in a mobile telecommunications network

Background of the invention

The invention relates to equipment and a procedure for supporting charging of subscribers with localised service areas in a mobile telecommunications network which comprises a packet radio network. An example of such networks is a combined GSM/GPRS network.

Fig. 1 is a block diagram illustrating a cellular telecommunications network supporting circuit-switched (CS) connections (e.g. Global System for Mobile Communication, GSM) and packet-switched (PS) connections (e.g. General Packet Radio Service GPRS). Circuit-switched connections are shown as solid lines and packet-switched connections are shown as dotted lines. The basic structure of the GSM system comprises two elements: a base station system BSS and a network subsystem NSS. The BSS and mobile stations MS communicate over radio links. In the base station system BSS each cell is served by a base station BTS. A number of base stations are connected to a base station controller BSC, which controls the radio frequencies and channels used by the BTS. Base station controllers BSC are connected to a mobile services switching centre MSC. As regards a more detailed description of the GSM system, reference is made to the ETSI/GSM recommendations and *The GSM System for Mobile Communications*, M. Mouly and M. Pautet, Palaiseau, France, 1992, ISBN:2-957190-07-7.

The GPRS infrastructure comprises support nodes such as a GPRS gateway support node (GGSN) and a GPRS serving support node (SGSN). The main functions of the GGSN nodes involve interaction with the external data network. The GGSN updates the location directory using routing information supplied by the SGSNs about an MS's path and routes the external data network protocol packet encapsulated over the GPRS backbone to the SGSN currently serving the MS. It also decapsulates and forwards external data network packets to the appropriate data network and handles the billing of data traffic.

The main functions of the SGSN are to detect new GPRS mobile stations in its service area, handle the process of registering the new MSs along with the GPRS registers, send/receive data packets to/from the GPRS MS, and keep a record of the location of the MSs inside its service area. The subscription information is stored in a GPRS register (HLR) where the

mapping between a mobile's identity (such as MS-ISDN or IMSI) and the PSPDN address is stored. The GPRS register acts as a database from which the SGSNs can ask whether a new MS in its area is allowed to join the GPRS network.

- 5 The GPRS gateway support nodes GGSN connect an operator's GPRS network to external systems, such as other operators' GPRS systems, data networks 11, such as an IP network (Internet) or a X.25 network, and service centres. A border gateway BG provides access to an inter-operator GPRS backbone network 12. The GGSN may also be connected directly to a
10 private corporate network or a host. The GGSN includes GPRS subscribers' PDP addresses and routing information, i.e. SGSN addresses. Routing information is used for tunnelling protocol data units PDU from data network 11 to the current switching point of the MS, i.e. to the serving SGSN. The functionalities of the SGSN and GGSN can be connected to the same physical
15 node.

- The home location register HLR of the GSM network contains GPRS subscriber data and routing information and it maps the subscriber's IMSI into one or more pairs of the PDP type and PDP address. The HLR also maps each PDP type and PDP address pair into a GGSN node. The SGSN
20 has a Gr interface to the HLR (a direct signalling connection or via an internal backbone network 13). The HLR of a roaming MS and its serving SGSN may be in different mobile communication networks.

- 25 The intra-operator backbone network 13, which interconnects an operator's SGSN and GGSN equipment can be implemented, for example, by means of a local network, such as an IP network. It should be noted that an operator's GPRS network can also be implemented without the intra-operator backbone network, e.g. by providing all features in one computer.

- In cellular mobile communications systems, a mobile station may roam freely within the area of the mobile communications network and connect
30 to the base transceiver station signal received best at a given time. Usually, all base transceiver stations provide substantially similar services for the mobile stations in a network. Some base transceiver stations can, however, be defined to provide a certain special service for all mobile stations of the network, e.g. call charges below the normal tariff. The base transceiver station
35 broadcasts a message concerning such a special service on its packet broadcast control channel (PBCCH), whereby mobile subscribers in the area

note that they are within a special service area of the network and may take advantage of this service.

Within the context of this application, such special service areas are referred to as localized service areas (LSA) and the support of LSA is called SoLSA. A subscriber having SoLSA service is called a SoLSA subscriber. A mobile station currently having support for SoLSA is said to be in LSA mode. This may mean e.g. that the mobile station indicates to its user that certain special features (like lower rates or extra services) are available, and it uses these features when applicable. The concept of localised service areas (LSA) is the subject matter of references 1 to 3.

Fig. 1 also shows two LSA areas, LSA1 and LSA2. LSA1 consists of cells C1 to C3, and LSA2 consists of cells C9 and C10. It is assumed that the mobile station MS moves, during a call, along path 10 from cell C1 to cell C10. The call is established in an LSA cell (C1). Between cells C1 and C2, the
15 MS moves slightly out of LSA1, in the sense that better coverage would be obtained from cell C7 which is not an LSA cell. However, the handover algorithm favours LSA cells and, consequently, the MS is not handed over to the base station of C7. When the MS crosses cell C4, the call cannot be maintained as an LSA call. When the MS approaches cell C9, it is handed
20 over to the base station of C9 and the call is again treated as an LSA call.

The present invention involves mainly charging-related aspects of SoLSA subscribers. Charging in a GPRS system is defined in reference 4. For charging, a telecommunications network generally comprises a billing system, such as the Billing Centre BC which may be connected to an MSC, as shown in Fig. 1. The network may also comprise dedicated Charging Gateways CG, as shown between the intra-operator backbone network 13 and the billing centre BC. (Alternatively, the dedicated charging gateways can be replaced by distributed functionality resident in the SGSN and GGSN nodes.)

According to reference 4, collecting charging information in a GPRS system can be briefly summarised as follows. Network elements, such as GPRS support nodes (SGSN and GGSN), monitor charging-related events (transmitting data packets, attaching to the network, mobility management, etc.) The network elements send charging data records, or CDRs, to the Billing Centre BC (possibly via Charging gateways CG). CDRs created by SGSN or GGSN nodes are called S-CDRs or G-CDR, respectively. In addition, an M-CDR conveys information on mobility management-related charging events.

- There are also SMO-CDRs and SMT-CDRs for MS-originated and MS-terminated short messages. For each charging-related event, there is a corresponding item or entry in the CDR. In the terminology of reference 4, the charging-related items are collectively referred to as a "List of Traffic Volumes". Reference 4 defines a set of rules for opening and closing each type of CDR, and the contents thereof.

A problem with prior art charging systems is that they completely ignore the SoLSA aspects.

Brief description of the invention

- An object of the invention is to provide mechanisms for supporting charging of users with localised service areas in a mobile telecommunications network which comprises a packet radio network. The object is achieved with equipment and a procedure which are characterized by what is disclosed in the attached independent claims. Preferred embodiments of the invention are disclosed in the attached dependent claims.

The invention is based on the idea that the packet radio network is adapted to classify the charging-related detail items of the CDR into multiple classes depending on whether or not the corresponding event occurred while the mobile station was in an LSA cell. This means that the mobility support element may actually classify the detail items into two classes, depending on whether or not the corresponding event occurred while the mobile station was in an LSA cell. Classifying the detail items into two classes is sufficient, if the LSA cells are similar as far as charging is concerned. If there are more than two types of charging, for instance more than two different tariffs, then the detail items should classified into a corresponding number of classes.

According to a preferred embodiment of the invention, a mobility support element, such as an SGSN node or a GGSN node, performs or at least supports this classification. Instead of performing the actual classification, the mobility support element may support later classification by sending charging detail records which at least indirectly indicate whether or not the mobile station was in an LSA cell (and what kind of LSA cell, if they are different charging-wise) when the corresponding event took place. Such indirect indication means that on the basis of the mobile station's LSA cell list, it is possible to classify the detail items in the CDR into two classes, depending on whether or not the MS was in a special cell.

According to a preferred embodiment of the invention, centralised charging is supplemented with distributed pre-processing in the support nodes of the packet radio network, preferably in the SGSN nodes. The reason for using the SGSN nodes for charging is as follows. The network element making decisions about handovers must be informed about the mobile station's LSA cells. In a GSM system, such a network element is the Base Station Controller BSC. In 3rd generation (3G) systems, it will probably be called Radio Network Controller RNC. (Later in this application, the term 'BSC' refers commonly to both a BSC and an RNC.) The network element which informs the BSC about the LSA cells is most conveniently the SGSN serving the mobile station MS. Thus the SGSN must be aware of the MS's LSA cells. Preferably, the MS-specific LSA information is included in a modified INSERT SUBSCRIBER DATA (IMSI, GPRS SUBSCRIPTION DATA, SoLSA PARAMETERS) message which the Home Location Register HLR sends to the serving SGSN when the MS initiates a GPRS ATTACH or a ROUTING AREA UPDATE procedure. The serving SGSN can deliver the subscriber-specific SoLSA parameters to the serving BSC e.g. in a modified BSSGP_DL_UNITDATA.REQ message or in a new dedicated BSSGP_SoLSA message. The BSC can take the SoLSA parameters into account in the network-controlled cell reselection, when a BSC-based solution will be used.

Because the SGSN must be aware of the MS's LSA cells, some synergy benefits will be achieved by using the SGSN as a pre-processor for charging.

Brief description of the drawings

The invention will be described in more detail by means of preferred embodiments with reference to the appended drawing in which:

Fig. 1 is a block diagram showing some elements of a packet radio network which are essential for describing the invention;

Fig. 2 is a signalling diagram illustrating a preferred embodiment of the invention;

Fig. 3 shows a possible interconnection of the network elements responsible for LSA management and charging; and

Figs 4A and 4B schematically illustrate charging detail records.

Detailed description of the invention

A limitation associated with prior art systems for providing special

services in a network is that SoLSA is only defined for circuit-switched connections, i.e. GSM and its derivatives. In a dual-mode GSM/GPRS network, the coverage of GSM and GPRS services may be different. Thus the prior art SoLSA provides little or no support for packet-switched connections,

5 e.g. GPRS. A specific problem with the prior art GSM SoLSA is encountered when a dual-mode mobile station with SoLSA active is involved in a GPRS connection. In such a situation, SoLSA support is discontinued because GPRS cell reselection does not take SoLSA into account. A solution for this problem is disclosed in Co-assigned Finnish patent application FI981130, "Solunvalinta pakettiverkossa", filed 20 May 1998. For convenience, the relevant subject-

10 matter of the '1130 application is repeated here. As shown in Fig. 2, a functioning GSM/GPRS interworking system can be attained by a method for controlling the operation of a mobile station, the operation comprising camping. The method is summarized as follows. The camping is modellable as

15 a number of states (S1 to S4) with predetermined state transitions (S₁₂ - S₃₄) between them, wherein each one of the states corresponds to a set of locally varying features which the mobile station currently supports. The features comprise a first feature indicating whether the mobile station is in circuit-switched mode or packet-switched mode, and a second feature indicating

20 whether or not the mobile station is in localised service area (LSA) mode. For all combinations of the first and second features, there is a corresponding state (S1 to S4), and for each one of these states, there are two originating state transitions and two terminating state transitions, each one of the originating state transitions corresponding to a change in the respective

25 feature.

Preferably, the criteria for the state transitions are based on the fact that of the two communications modes, i.e. circuit-switched and packet-switched, one has better coverage. In a combined GSM/GPRS system, GSM typically has better coverage than GPRS. Thus, in situations where there is a

30 possible conflict between a state transition based on GSM criteria and a state transition based on GPRS criteria, it is advantageous to use the GPRS criteria to determine whether the mobile station is in SoLSA mode or not. Such a conflict may occur when the mobile station has an activated GPRS context (in Standby or Active state). In such a situation, the mobile station would not

35 perform state transition T₁₂ unless T₃₄ is also possible.

- The block diagram of Fig. 3 shows a possible interconnection of the network elements responsible for LSA management and charging. Subscriber-specific LSA information can be stored and managed either in the Camel Service Environment CSE or in the Home Location Register HLR. Two types of LSAs can be foreseen, either a truly customised LSA for a small office area and a residential area ("office/home zone"), or a predefined LSA covering large campuses, sections of cities and districts ("city zones"), etc. These two LSAs fulfil different needs. They complement each other and they can be used simultaneously. A SoLSA subscriber can have a home LSA consisting of 1 or 2 cells, an office LSA consisting of 1 to 5 cells and a city LSA with dozens or hundreds of cells. The first two LSAs are preferably tailored on a per-subscriber basis. A truly subscriber-specific LSA can be defined on a cell identity basis and it can be very small, even consisting of only one cell, if necessary. The third LSA could rely on a certain predefined LSA definitions.
- LSA information can consist of:
- List of cell identities belonging to an LSA (e.g.: Cell Global Identity (MCC+MNC+LAC+CI), MNC+LAC+CI LAC+CI or CI).
 - LSA_ID (The LSA ID is a number uniquely assigned to an area in one network. LSA ID can be associated with a Cell Identity list.)
 - LSA name (a text string describing an area and/or service, e.g. "Etsi Building").
 - LSA indication (a flag to activate/deactivate LSA indication)
 - LSA priority (a number value needed to support overlapping LSAs, for example a city zone and office cells in the same area).
 - LSA only access (Service outside LSAs is restricted).
 - LSA only access indication text (Text to be displayed when out of LSA area).
 - Exclusive access (User has exclusive access to a LSA).
 - Relevant MSP profile (an LSA may be associated with some MSP profiles).
 - Idle/active mode support (preferred cell selection in idle/active mode may be utilised in an LSA).

The network operator can use the Network Management Services NMS to define the subscriber's LSA areas. There can be one common list of LSA areas for a given subscriber. In this case, there are virtually no GSM/GPRS interworking problems. The subscriber's LSA data should be transferred to the BSC via circuit-switched (CS) and packet-switched (PS)

connections, as needed (e.g. during call set-up for CS, and during GPRS Attach and inter-SGSN handover for PS). The LSA list should be broadcast on the BCCH and PBCCH (if allocated).

Alternatively, the LSA areas may be different for CS and PS services. In this case, the HLR has to store two separate LSA lists. However, it is sufficient to store only a single LSA list in the MS's SIM card. If no PBCCH is allocated, both CS and PS LSA lists should be broadcast on the BCCH. If both BCCH and PBCCH are allocated, there are at least two configuration options:

1) CS LSA ids are broadcast on the BCCH only, and PS LSA ids are broadcast on the PBCCH only. In this case, the priorities are applicable only inside CS and PS LSA areas.

2) Both CS and PS LSA ids are broadcast on the BCCH and PBCCH. Such a configuration is simpler than the previous one because the LSA priorities are followed in all situations.

For circuit-switched SoLSA, the BSC needs the subscriber's LSA data for active mode support in the BSC. A corresponding mechanism for packet-switched SoLSA should be implemented because the LSA data is needed for network-controlled cell reselection. The network-controlled cell reselection parameters are broadcast on the Packet Broadcast Control Channel PBCCH, and they are valid for all mobile stations in Ready state in the cell in question. Cell reselection commands can also be sent to an individual MS on a Packet Access Control Channel PACCH, in which case such a command overrides the PBCCH parameters. The SGSN nodes can get these parameters from the HLR e.g. in a modified INSERT SUBSCRIBER DATA message, whose parameters include the subscriber's IMSI, GPRS Subscription data and the SoLSA parameters). The HLR can send this message to the SGSN e.g. in response to a GPRS Attach procedure. The SGSN can deliver the subscriber-specific SoLSA parameters to the BSC serving the MS e.g. in a modified BSSGP_DL_UNITDATA.REQ message or in a new dedicated BSSGP_SoLSA message. The BSC can take the SoLSA parameters into account for the network-controlled cell reselection, if a BSC-based solution is used.

To summarise, the BTS sends to the MS:

- on the BCCH: CS LSA_id list, CS LSA cell reselection parameters, and the cell_id;

- on the PBCH (if allocated): PS LSA_id list, PS LSA cell reselection parameters, the cell_id and network-controlled cell reselection parameters;
- on the PACCH: individual cell reselection commands.

In each of these cases, it can be seen that the LSA parameters are
5 needed for supporting the mobility of the mobile station, and for charging its subscriber. Therefore, certain synergy benefits will be achieved by using mobility support elements of the networks also as a pre-processor for charging purposes, as will be described below in more detail.

According to a primary embodiment of the invention, the Base
10 Station Controller BSC currently serving the mobile station MS adds the MS's current cell identity (cell_id) into the data packets it sends to the serving SGSN. Thus the SGSN knows the cell identity of the mobile-originated (MO) packets. When the MS is in Ready mode, the SGSN also knows the cell_id of the MS before it sends mobile-terminated (MT) packets to the MS. Otherwise,
15 the SGSN pages the MS, after which it knows the MS's current cell_id. In conclusion, the SGSN always knows the cell_id of the MS for both MO and MT packets.

There are at least two ways in which the network can correlate the charging-related aspects of data transmission with the cell_id of the cell where
20 the MS has sent or received data. For example, Fig. 4A depicts schematically a set of CDRs, CDR1 to CDR3, such that each CDR includes information from only one tariff zone (in this case, only one LSA). Each CDR includes a header. (For the purposes of this application, the word 'header' has a wide interpretation, in the sense that it comprises everything which is required by
25 the relevant standards but which is not listed as detail items elsewhere in the CDR.) As long as the MS remains in the same LSA, the SGSN keeps open the S-CDR. When the MS moves to a different tariff zone, the previous S-CDR will be closed and a new one will be created. The set of CDRs comprising CDR1 to CDR3 correspond to the scenario of Fig. 1, wherein the MS moves along
30 the path 10 from cell C1 to cell C10. As long as the MS is in LSA1 (i.e. cells C1 to C3), the SGSN keeps CDR1 open and collects charging-related detail items (item11 to item 13, etc.) CDR1 also shows that all the items in it relate to events in an LSA whose LSA_id is 1 (i.e. LSA1). Similarly, CDR2 includes items relating to events which took place while the MS was in cell C4, which is
35 not in an LSA (at least, to this subscriber) and which does not have an LSA_id. CDR3 includes items relating to events which took place while the MS was in

cells C9 and C10, which to this subscriber constitute LSA2 having an LSA_id of 2.

In CDRs according to reference 4, the LSA_id can be transferred e.g. in a field called "Record extensions", but, preferably, a dedicated field 5 should be defined for this purpose.

Fig. 4B shows a different CDR4, wherein each detail item has the corresponding LSA_id next to it. In this case, the format of the CDR according to reference 4 is definitely not sufficient, because the "Record extensions" field is common to the entire CDR.

10 Figs. 4A and 4B show embodiments wherein the full LSA_id is included in the CDR. For charging purposes, it is sufficient to include only yes/no information, indicating whether or not the MS was in an LSA cell when the relevant event took place.

According to a secondary embodiment of the invention, the SGSN 15 may not know the MS's SoLSA parameters, or the manufacturer or the operator prefers not to add to the complexity of the SGSN in the manner described in connection with the primary embodiment. In such a case, the format of the S-CDR can be changed so that its detail items (the List of Traffic Data Volumes field) record the cell_id and data volume for every different 20 cell_id. Sorting the cells into LSA cells and non-LSA cells according to the MS's SoLSA parameters can take place in the Charging Gateway or the Billing Centre.

It is also possible to support SoLSA charging without changing the format of the S-CDR. In this case, the MS's most current cell_id is determined 25 at the time when the S-CDR is created, and this cell_id will be used as a basis for charging. The cell where a GPRS ATTACH or a ROUTING AREA UPDATE procedure is performed determines the tariff zone. The changes in the MS's Routing Area are recorded in the M-CDR, and they could also be used for determining the tariff zone. If the LSA borders were also Routing Area borders, 30 no other correlation mechanism would be needed. However, SoLSA charging based on existing CDRs is considered inflexible.

The description only illustrates preferred embodiments of the invention. The invention is not, however, limited to these examples or the terms used, but it may vary within the scope of the appended claims.

References:

1. Co-assigned PCT publication WO98/30056, "*Localised special services in a mobile communications system*"
2. ETSI Draft TS 03.73 v. 0.5.0 (April 1998)
3. ETSI Draft TS 02.43 v. 0.0.0 (July 1998)
4. ETSI Recommendation GSM 12.15, v. 2.0.0 (June 1998).
5. Co-assigned Finnish patent application FI981130, "*Solunvalinta pakettiverkossa*"

All references are incorporated herein by reference.

Claims

1. A method for supporting charging of a subscriber of a mobile station (MS) in a cellular radio network supporting circuit-switched and packet-switched connections to/from the mobile station (MS) and comprising several cells (C1 - C10) and at least one mobility support element (MSC/VLR; SGSN, GGSN) being adapted to receive, when it begins to serve the mobile station, a set (LSA1, LSA2) of special cells (C1 - C3, C9 - C10) for the mobile station, and being adapted to send the set of special cells to one radio control element (BSC1, BSC2);
10 the method comprising the steps of:
 defining, for each of several mobile stations (MS), a respective set (LSA1, LSA2) of special cells providing at least one special service to the mobile station (MS);
 determining whether or not the mobile station (MS) is in a special
15 cell; and
 producing charging information (CDR) related to the mobile station, the charging information comprising detail items, each detail item indicating an event which affects charging;
 c h a r a c t e r i z e d in that
20 said detail items are classified into multiple classes depending, at least, on whether or not the corresponding event occurred while the mobile station was in a special cell.
2. A method according to claim 1, c h a r a c t e r i z e d in that the mobility support element (MSC/VLR; SGSN, GGSN) performs or at least
25 supports said classification.
3. A cellular radio network being operable to support circuit-switched and packet-switched connections to/from a mobile station (MS), the network comprising several cells (C1 - C10), and:
30 for each of several mobile stations (MS), a respective predefined set (LSA1, LSA2) of special cells providing at least one special service to the mobile station (MS);
 at least one radio control element (BSC1, BSC2) for determining whether or not the mobile station (MS) is in a special cell;
 at least one mobility support element (MSC/VLR; SGSN, GGSN)
35 being adapted to receive, when it begins to serve the mobile station, the set

- (LSA1, LSA2) of special cells for the mobile station, and being adapted to send the set of special cells to one radio control element (BSC1, BSC2); and at least one charging element (CG, BC) for receiving charging information related to the mobile station, the charging information comprising
- 5 detail items, each detail item indicating an event which affects charging; characterized in that the network is adapted to classify the detail items into multiple classes depending, at least, on whether or not the corresponding event occurred while the mobile station was in a special cell.
- 10 4. A cellular radio network according to claim 3, characterized in that the mobility support element (MSC/VLR; SGSN, GGSN) is adapted to support or perform said classification.
- 15 5. A cellular radio network according to claim 3 or 4, characterized in that the mobility support element is a serving GPRS support node (SGSN), known per se, and the serving GPRS support node is adapted to compare the cell identity (cell_id) of the MS's current cell with the set (LSA1, LSA2) of special cells for the mobile station.
- 20 6. A cellular radio network according to any one of claims 3 to 5, characterized in that substantially each detail item indicates whether or not the cell in question is a special cell.
- 25 7. A cellular radio network according to any one of claims 3 to 5, characterized by being adapted to organise the detail items as consecutive records (CDR), wherein substantially each record indicates whether or not all events indicated by the detail items of the record occurred while the mobile station was in a special cell.
- 30 8. A cellular radio network according to any one of claims 3 to 7, characterized in that the mobility support element (MSC/VLR; SGSN, GGSN) inserts to each detail item the identity (cell_id) of the cell where the mobile station was when the event occurred.
9. A mobility support element (MSC/VLR; SGSN, GGSN) for a cellular radio network comprising several cells, and being operable to support circuit-switched and packet-switched connections to/from a mobile station

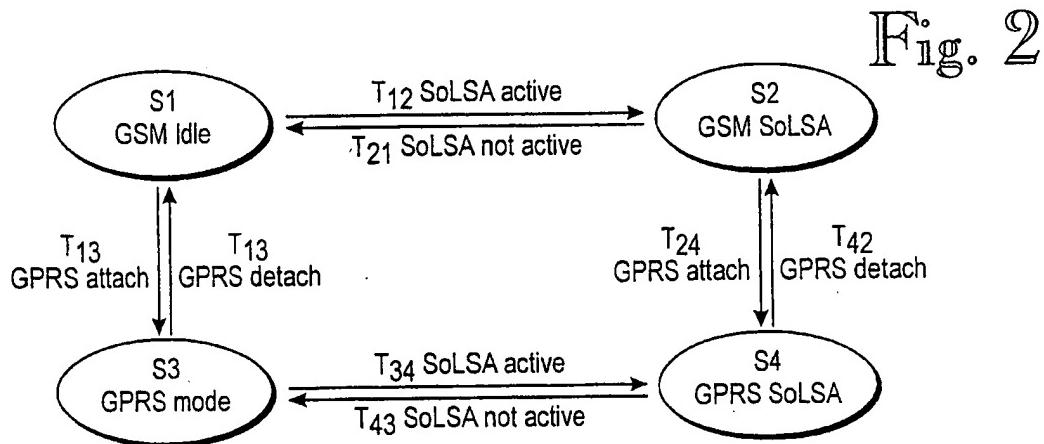
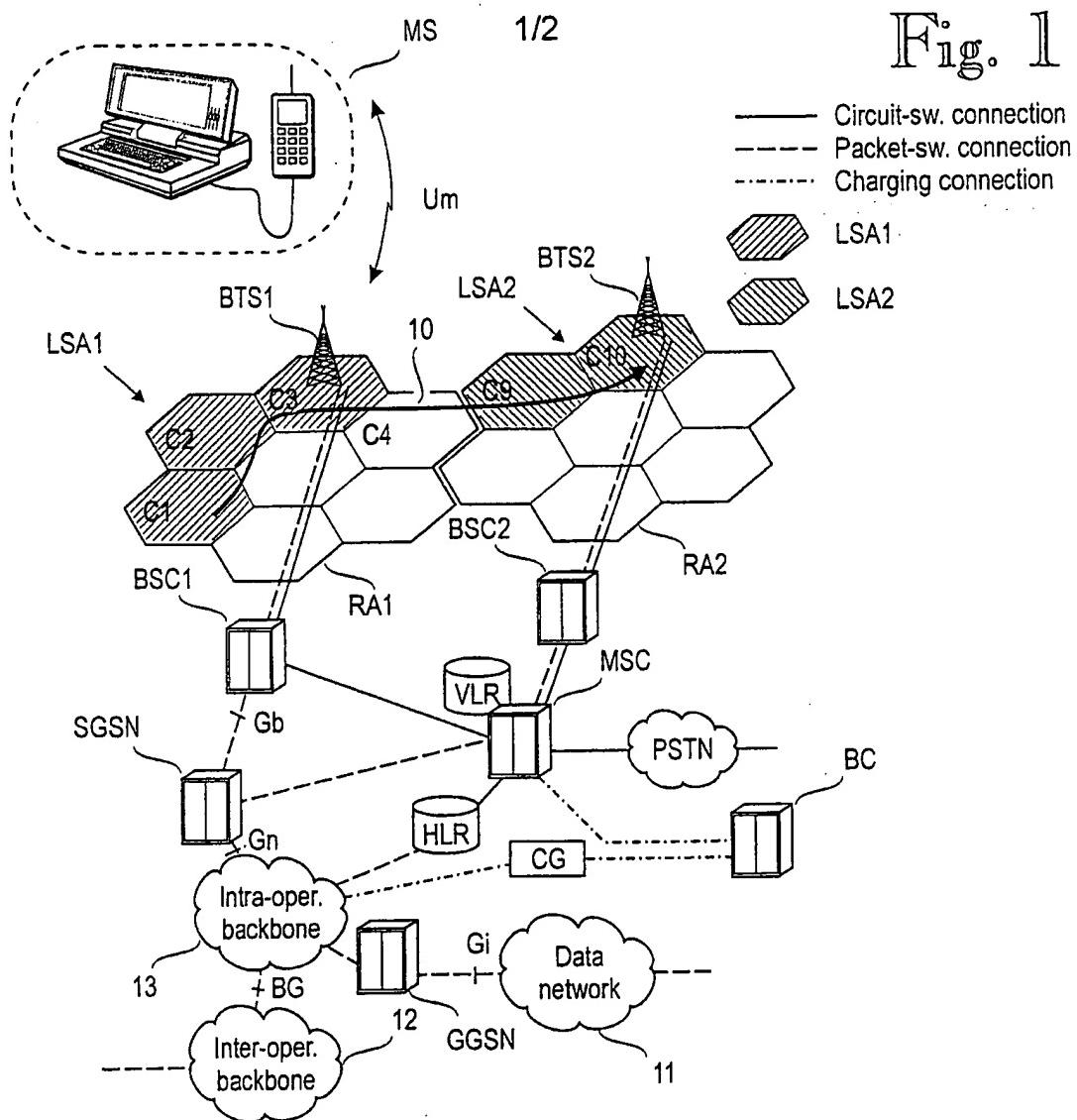
- (MS); the network further comprising for each of several mobile stations (MS), a respective predefined set (LSA1, LSA2) of special cells providing at least one special service to the mobile station (MS); at least one radio control element (BSC1, BSC2) for determining whether or not the mobile station (MS)
- 5 is in a special cell; and at least one charging element (CG, BC) for receiving charging information related to the mobile station, the charging information comprising detail items, each detail item indicating an event which affects charging;

wherein the mobility support element (MSC/VLR; SGSN, GGSN) is
10 adapted to receive, when it begins to serve the mobile station, a list of special cells for the mobile station, and it to send said list of special cells to one radio control element (BSC1, BSC2);

characterized in that the mobility support element is adapted to support or perform classification of said detail items into multiple classes
15 depending on whether or not the corresponding event occurred while the mobile station was in a special cell.

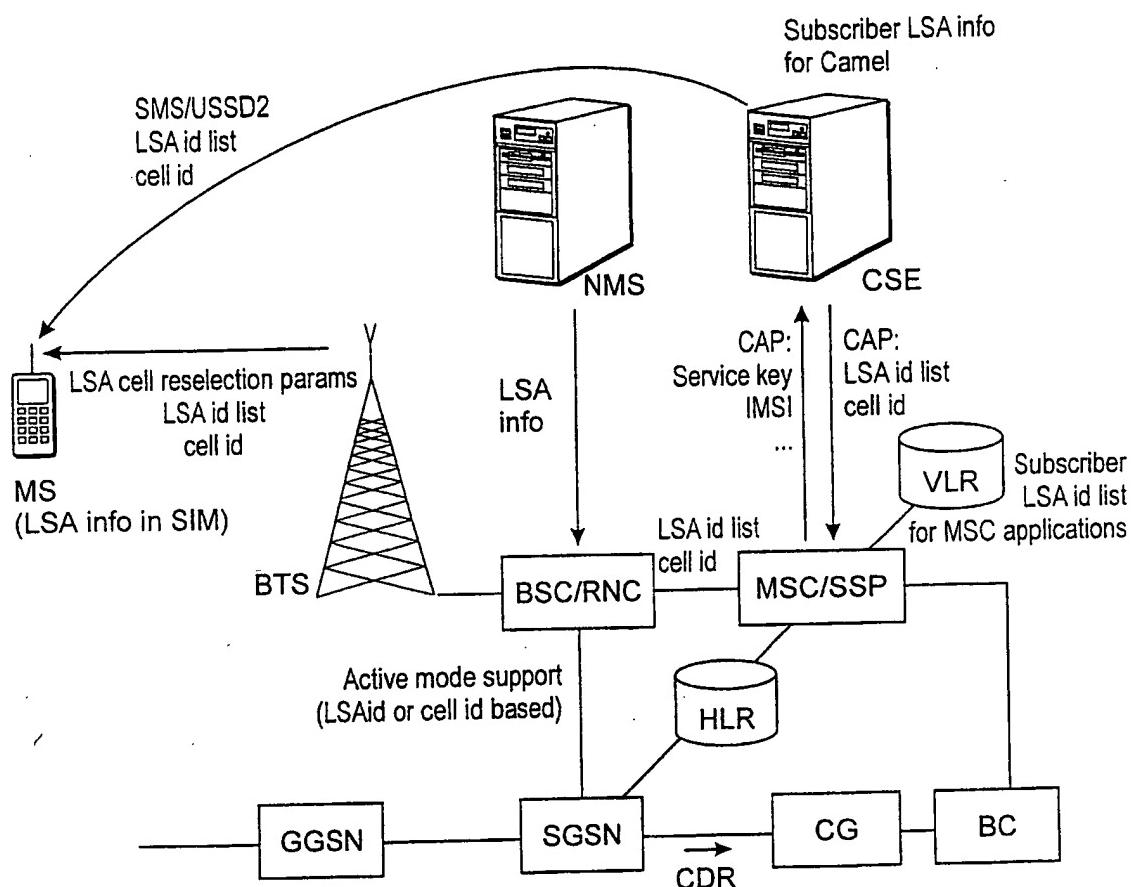
10. A charging-related message (CDR1 - CDR4) for a cellular radio network comprising several cells, each cell having a cell identity (cell_id), and being operable to support circuit-switched and packet-switched connections
20 to/from a mobile station (MS); the network comprising for each of several mobile stations (MS), a respective predefined set (LSA1, LSA2) of special cells (C1 - C3, C9, C10) providing at least one special service to the mobile station (MS); said charging-related message including at least one detail item for substantially each event that affects the charging of the subscriber of the
25 mobile station;

characterized in that for substantially each detail item, said charging-related message (CDR1 - CDR4) at least indirectly indicates whether or not the mobile station was in a special cell (C1 - C3, C9, C10) when the corresponding event occurred.



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Fig. 3



CDR1

CDR2

CDR3

Fig. 4A

Header
LSA_id=1
item 11
item 12
item 13
...

Header
LSA_id=xx
item 21
item 22
item 23
...

Header
LSA_id=2
item 31
item 32
item 33
...

CDR4

Fig. 4B

Header
item 11, LSA_id=1
item 12, LSA_id=xx
item 13, LSA_id=2
...

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00750

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/38, H04Q 7/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9748245 A1 (NOKIA TELECOMMUNICATIONS OY), 18 December 1997 (18.12.97), page 3, line 7 - page 4, line 25; page 6, line 1 - line 12, abstract	1,2,10
Y	--	3-9
Y	EP 0597638 A1 (VODAFONE LIMITED), 18 May 1994 (18.05.94), column 3, line 24 - line 30	3-9
A	WO 9620570 A1 (NOKIA TELECOMMUNICATIONS OY), 4 July 1996 (04.07.96), abstract	1-10

 Further documents are listed in the continuation of Box C. See patent family annex.

- * Special categories of cited documents:
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- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 January 2000	01-02-2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Stefan Hansson/MN Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.	
PCT/FI 99/00750	

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WO	9620570	A1	04/07/96	AU AU CA CN EP FI FI JP NO	701960 B 4262396 A 2207426 A 1171185 A 0800748 A 97510 B,C 946091 A 10511520 T 972889 A	11/02/99 19/07/96 04/07/96 21/01/98 15/10/97 13/09/96 24/06/96 04/11/98 20/06/97